

BRITISH JOURNAL OF TUBERCULOSIS AND DISEASES OF THE CHEST

Vol. XLIV.

July, 1950

No. 3.

GENERAL ARTICLES

A CASE OF MALIGNANT THYMIC TUMOUR ASSOCIATED WITH CHRONIC PULMONARY TUBERCULOSIS

By MAURICE DAVIDSON

[WITH AUTOPSY NOTES BY C. KEITH SIMPSON]

IN most cases of advanced pulmonary tuberculosis the clinical manifestations and the natural course of the disease are familiar enough and afford no reason for special comment. Occasionally, however, one is presented with unusual phenomena which do not fit in with the general picture and which give rise to no little anxiety, not only with regard to diagnosis but also with regard to treatment and general management. A good example of this is furnished by the following case, which presents certain features of unusual interest that seemed to me to be worth recording.

The patient was an unmarried woman aged 52. She first consulted me in December 1941, when she was complaining of hoarseness of voice of about six weeks' duration, morning cough, and some general lassitude. There was a history of an attack of pleurisy on the left side in 1926, and again a similar attack in 1931, otherwise there was nothing to suggest active tuberculous disease of the lung in the past. No physical signs of significance were found in the chest, but X-ray examination showed a fibrotic lesion in the right upper lobe and some general fibrosis in the left lung. The lesions appeared to be of old standing; there was some general emphysema. Examination of the larynx showed slight thickening of the left vocal cord from tuberculous infiltration.

She was admitted to the Brompton Hospital for further examination and assessment. During the fortnight she was in hospital she was afebrile: one specimen of sputum was examined for tubercle bacilli, with negative result. Early in February 1942 she was sent to Frimley Sanatorium, where a positive sputum was found on one occasion. She remained there for fourteen weeks, during which time she made good progress. Subsequent X-ray examinations of the chest had shown no evidence of progressive pulmonary disease; the laryngeal symptoms had improved; and she was finally discharged as fit to resume her work, though she was advised to rest her voice as much as possible.

Examination of the larynx in June 1942 showed a considerable improvement in comparison with the original condition. When seen in September 1942 she appeared in very fair general health; no further laryngeal symptoms were observed, and she was referred to her own medical attendant, with advice to report at intervals for observation.

I heard nothing further of her until the beginning of March 1950, when I was asked to see her urgently on account of a fairly severe attack of hæmoptysis, which had occurred suddenly about a fortnight before. Her medical attendant informed me that since the onset of the hæmorrhage she had had considerable pyrexia, the evening temperature rising to 103°, or more, and that there was a fair amount of sputum which on examination had shown tubercle bacilli present in large numbers. On physical examination there were definite signs of active disease in the left upper zone; her general condition was very fair and there had been no obvious loss of weight, but she complained of marked general weakness and exhaustion, which seemed to me at the time to be out of proportion to the objective evidence of disease in the lungs and to the general constitutional disturbance.

On March 6, when she had got over the initial shock of the hæmoptysis and was feeling a little better, I had her taken to Brompton for X-ray examination. The general fibrosis on both sides appeared much as before, but it was now evident that two fairly large cavities were present in the left upper zone (see Fig. 1). She was advised to continue at home on strict bed rest under the care of her own doctor, and to go on with the course of streptomycin injections, which had been started a few days before, in combination with oral administration of P.A.S. For a time she seemed to improve, the temperature chart showing a gradual but definite defervescence, but she still complained of a feeling of utter exhaustion, for which the pulmonary disease, though admittedly active, seemed to me insufficient entirely to account. On March 14 she suddenly became very much worse. Her temperature, which had gradually fallen to normal, suddenly dropped to 95°, and the pulse rate rose to 140. Profuse sweating occurred and she became extremely dyspnoeic. The following day she seemed a trifle better, but the tachycardia and dyspnoea persisted. On examination an extensive area of hyper-resonance appeared in the lower part of the left axillary region, and over this area were audible amphoric breathing and an amphoric tinkle at the end of inspiration. Her doctor and I both thought that in all probability a rupture of the lung had occurred leading to a spontaneous pneumothorax, which would have accounted for the sudden collapse and the onset of the marked respiratory distress, and she was again admitted to Brompton as an emergency case on March 15.

Shortly after admission a portable X-ray of the chest was taken, which showed the left diaphragm to be unusually high in position, the hyper-resonance previously noted being obviously due to extreme gastric distension. A dense opacity was seen in the lower half of the chest on the right side. The right pleural cavity was thereupon aspirated, and about half a pint of turbid straw-coloured fluid was removed. This was found on examination to contain only débris. No acid-fast bacilli were found, and cultures for secondary organisms were sterile after forty-eight hours' incubation. A white cell count showed the total leucocytes to be 4,000 per c.mm. (neutrophils being 70 per cent., lymphocytes 28

PLATE V.

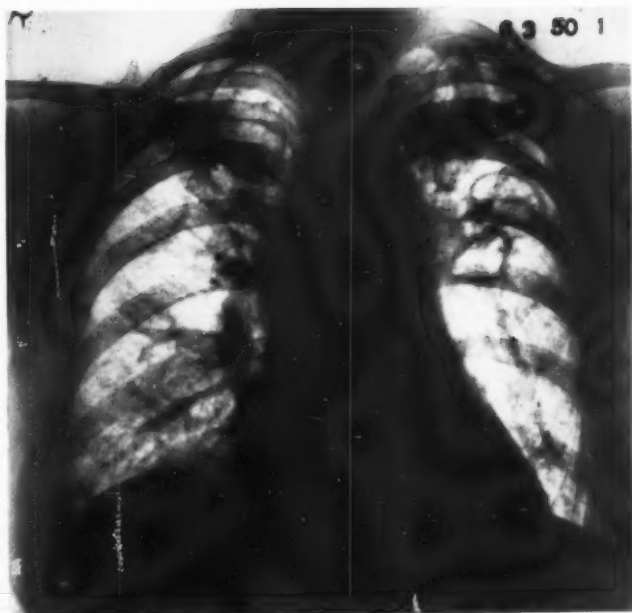


FIG. 1.—Radiogram of chest showing recent excavation of left lung.

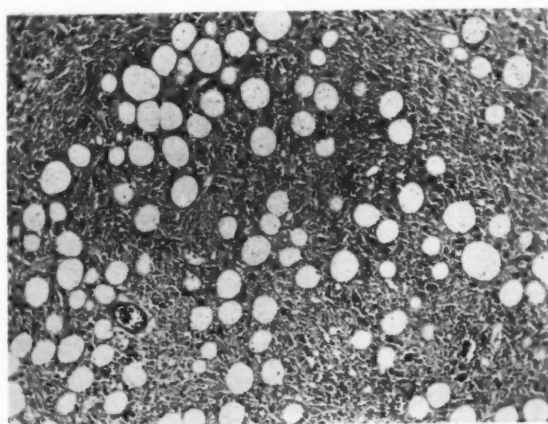
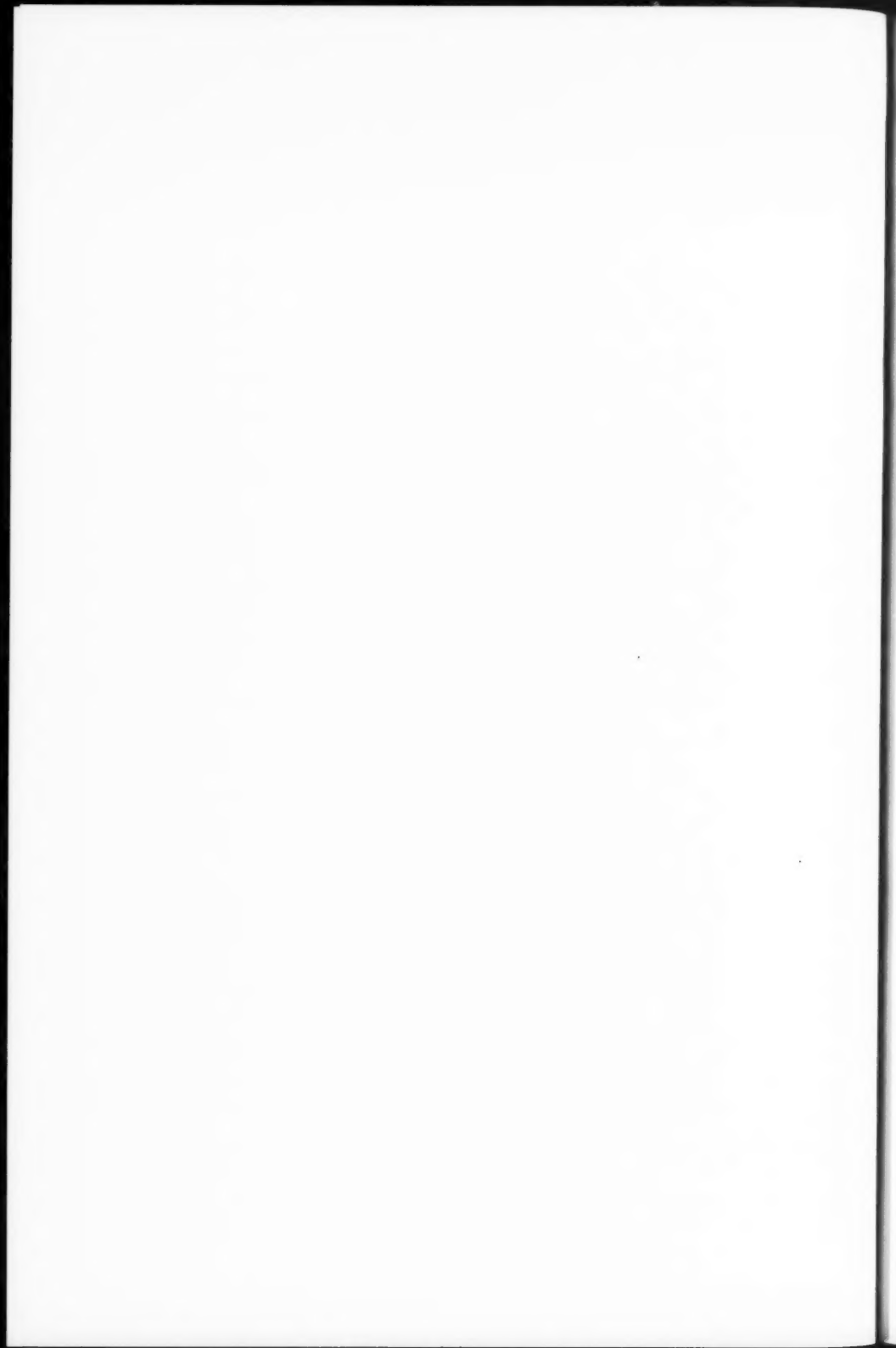


FIG. 2.—Microphotograph of Thymic Tumour.

To face page 56



per cent., and monocytes 2 per cent.). From this time onward her condition became rapidly worse; she gradually passed into coma and died early the following morning.

The post-mortem examination, conducted by Dr. Keith Simpson, showed the deceased to have a fair general nourishment without significant loss of flesh. The following pathological conditions were found.

The pericardial sac was found to contain about 6 ounces of yellowish fluid. No fibrinous deposit was seen on the visceral layer. No disease of the heart itself was apparent.

Active tuberculous ulceration of the larynx, with finely nodulated thickening of the left vocal cord, was associated with tuberculous disease excavating the apex of the left lower lobe (3.5 cm. and 1.5 cm. cavities), and with inactive interstitial and scattered nodular tuberculous lesions in most parts of the left lung, virtually healed at the apex, and also at the right apex. At the right apex the disease was fibrous, inactive and virtually healed. The rest of the right lung was clear, except for a solitary recent infarct at the lower border of the lower lobe in the axillary line, a wedge-shaped hæmorrhagic lesion measuring 6 cm. by 2.5 cm. and causing a small effusion on this side. Paracentesis had reduced the quantity of fluid to between 4 and 5 ounces; it was fibrinous and tinged faintly with blood.

A primary thymic tumour measuring about 10 cm. by 2 cm., discoid, occupied the position of the gland, but had clearly caused no pressure on or displacement of nearby organs. A 5-cm. cyst lay in its interior. Microscopic examination of this tumour showed it to be composed of sheets of undifferentiated large mononuclear cells supported by a fine reticulum, characteristic of the locally malignant thymoma (see Fig. 2). The lesion was clearly unrelated to the other pathological conditions.

No phlebo-thrombosis was found in the limbs, and the clot formed in the branch of the right pulmonary artery was, therefore, thought to be a primary intrapulmonary thrombus.

Two points in the above account seem to call for some remark. First is the simulation of the clinical picture of pneumothorax by an overdistended stomach. It is easy to be wise after the event. At the time when this patient first exhibited sudden collapse, the cause of the phenomena was by no means clear; portable X-rays were not at the moment available, and careful and complete examination of the chest was hardly possible owing to her desperate condition. A diagnosis of spontaneous pneumothorax appeared to fit in with the physical signs present and to account adequately for the sudden onset of respiratory distress. Secondly, the presence of a thymic tumour, undetected during life, has given rise to some interesting speculations. Emphasis has already been laid on the patient's complaint of intense weakness, for which the disease of the lungs alone appeared an insufficient explanation. In myasthenia gravis the outstanding feature is abnormal and rapid fatigability of muscles, giving rise to the complaint of great weakness. A not uncommon finding in this disease is a persistent and enlarged thymus gland. Russell Brain² states that 10 per cent. of myasthenic patients have a thymic tumour, usually benign, but sometimes malignant. Kinnier Wilson³ mentions persistent thymus as a feature in 50 per

cent. of cases, and Blalock¹ quotes reports up to 1940 of fifty-four instances of thymic abnormality in approximately 110 autopsies on patients with myasthenia gravis.

This patient showed none of the classical signs of myasthenia gravis during life, and her weakness and tendency to dyspnoea on exertion, which had been noticed by her relatives for some months before her last illness, were attributed to reactivation of the old tuberculous lesions in the lung. In view of the unexpected disclosures of the autopsy it is conceivable that her unusual weakness may have been of a type similar to that encountered in myasthenic patients. The association between thymic abnormality and the peculiar fatiguability of muscles in myasthenia gravis has long been a subject of discussion in neurological literature; such association, however, shows no constancy. A persistent thymus gland may be found in patients who have no signs of myasthenia, and at least 50 per cent. of myasthenics show no thymic abnormality. Moreover, the beneficial effects of thymectomy in myasthenics, though often striking, are hardly predictable. The precise mechanism of death in this case is not entirely clear, a complex pathology having been revealed by the post-mortem examination. It is at least possible that weakness of the respiratory muscles (diaphragm and intercostals) may have been a factor, and that the thymic tumour may have had some share in the aetiology of this rather unusual case.

I am indebted to the courtesy of H.M. Coroner, Dr. Neville Stafford, for permission to attend the autopsy and to publish the details of the post-mortem findings.

REFERENCES

1. BLALOCK, A.: *Amer. J. Surg.*, 1941, **54**, 149.
2. BRAIN, W. R.: *Diseases of the Nervous System*, 3rd Ed., p. 829. (Oxford University Press, 1947.)
3. WILSON, S. A. K.: *Neurology*, vol. 2, pp. 1595-1607 (London; E. Arnold and Co., 1940.)

ARTERIO-VEINUS ANEURYSM OF THE LUNG WITH PULMONARY TUBERCULOSIS

REPORT OF A CASE

By C. KELMAN ROBERTSON

From the Royal Infirmary of Edinburgh

FEW cases of arterio-venous aneurysm of the lung have been recorded. The first note on this subject appeared in 1936,¹ and until 1949 only 31 recorded cases could be traced in the literature.² No doubt, however, as the syndrome associated with the abnormality becomes better known many more cases will be published.

The presenting features of the anomaly are such that the differential diagnosis has been considered³ to be cyanotic congenital heart disease, polycythaemia vera, bronchiectasis and pulmonary tuberculosis, but with careful clinical examination and the use of such ancillary aids as we have at our command at present the diagnosis can usually be made absolute and appropriate treatment

recommended. The justification for placing the following case on record is that the condition is still considered to be unusual, and that in this particular instance the picture was complicated by superadded pulmonary tuberculosis.

There was, as will be seen from the notes, very little opportunity of investigating the case fully; nevertheless it is deemed worthy of publication because of aberrant data which gave rise to difficulty with diagnosis.

CLINICAL HISTORY

A young man aged 27 years was admitted to hospital on 30.9.49. He was mentally confused and unable to give any history. Facts that were obtained were indifferently given by the people with whom he and his father lodged. Fourteen days prior to admission the patient had become ill with fever and a cough; this had been considered to be "a chill." Medical advice was not sought until the day of transfer to hospital. On careful questioning of the father it was found that the patient was an only child who had not had any outstanding illnesses, but that he had been subject to recurrent nose bleedings. He had not been accepted for military service on account of heart trouble. The father recalled that on the night of May 8, 1945 (VE day), the boy's lips had become suddenly blue after he had taken part in a somewhat boisterous celebration sing-song, and this had remained with him ever since. The ends of the fingers had been flattened and blue for many years. He had always been excitable and his eyes had been prominent for many months. Boyhood was seemingly normal, schooling having continued until the age of 15 years, when he thereafter worked as a brass finisher and turner. He had, however, seemed to lose interest in his work from the time of his mother's death eighteen months previously, but this was attributed to that bereavement. During 1948 a radiograph of his chest had been taken at a Mass Radiography Unit. The result of this was not known.

CLINICAL EXAMINATION

The patient was very emaciated, confused, restless, had a deep cyanotic colour and was markedly dyspnoeic.

Bilateral exophthalmos was prominent. Clubbing of fingers and toes was pronounced. The skin was dry, extremities cold, and there was a very coarse tremor of the hands. The thyroid was not enlarged. Temperature was 97.8° F.

Cardiovascular System.—Pulse rate 150 per minute, regular. B.P. 100 systolic, 40 diastolic. Neck veins slightly distended. Apex beat impalpable. All heart sounds closed.

Respiratory System.—Respiration rate 40 per minute. Chest movement uniform. Impairment of percussion note left base. Amphoric breath sounds left apex. A harsh systolic murmur was heard at the left base which did not vary in quality with the phases of respiration. There was a little mucopurulent sputum.

Abdomen.—The abdomen was scaphoid with visible epigastric pulsation and the spleen was palpable.

Central Nervous System.—The tendon reflexes were depressed. Fundal vessels were engorged.

Blood examination.—Hæmoglobin 108 per cent. Red blood cells 6.8 million per c.cm. Leucocytes 8,500. B.S.R. 80 mm. plasma in one hour.

Urine.—Albumin present, no cells, no casts.

As the patient was critically ill it was impossible to carry out any further investigations than those noted. Emergency treatment was given consisting of oxygen, morphia and aminophylline. His general condition deteriorated very rapidly and he died 24 hours after admission to hospital.

EXCERPTS FROM AUTOPSY REPORT

Lungs.—Dense fibrous adhesions were present in both pleural sacs. The parietal pleura was studded with numerous small white tubercles as were both leaves of the diaphragm. There was a large subapical cavity with thick, irregular fibrotic walls and a caseous lining. Around this cavity were multiple small tuberculous foci with innumerable miliary spots of broncho-pneumonic and blood-borne origin. Many similar spots were scattered throughout the left lower lobe.

A large arterio-venous fistula was found in the left lower lobe lying on the lateral aspect just beneath the pleura (Fig. 1.) Two large branches of the left pulmonary artery passed downwards and outwards from the hilum, one entering the fistula anteriorly and the other posteriorly, draining into the pulmonary vein through a large venous cavern. The anastomosis was of a large calibre and must have conveyed a large quantity of blood direct from the venous to the arterial circulation.

There was an elongated soft-walled cavity in the subapical region of the right lung as well as multiple scattered areas of caseation having the character of aspiration bronchopneumonia. Microscopic examination bore out the widespread distribution of tuberculosis throughout both lungs.

Heart.—There was no evidence of any valvular abnormality. The size of the organ was within normal limits and there was no right-sided dilatation.

Spleen.—340 gm.; was slightly enlarged and riddled with miliary tubercles of varying size.

Liver.—1,940 gm.; enlarged with many tubercles, some showing caseation.

Thyroid.—Normal size and on section the gland tissue appeared normal.

Kidneys and pancreas showed miliary tubercles.

The left orbit was opened, but did not reveal any abnormality.

Fortunately it was possible to trace the film taken at the Mass radiography Unit on 13.5.48 (Fig. 2). This showed an irregular opacity in the outer part of the left lower zone and a smaller opacity above the right hilum. The size of the heart seemed to be within normal limits. As the opacities were of uncertain nature further examination was desired, and the patient was written to asking him to report back to the unit. He did not, however, return as requested.

Discussion

Some of the salient features of this case are worthy of note. The history of frequent nose-bleeding suggests that angiomas may have been present in the nasal mucosa, but this area was unfortunately not examined because of the

PLATE VI.

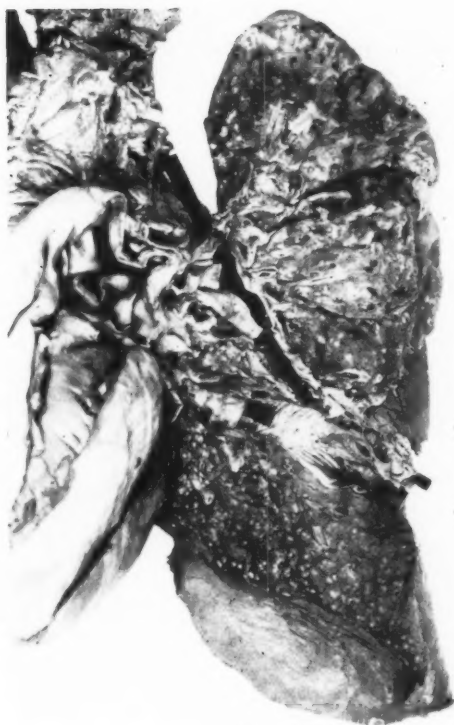


FIG. 1.

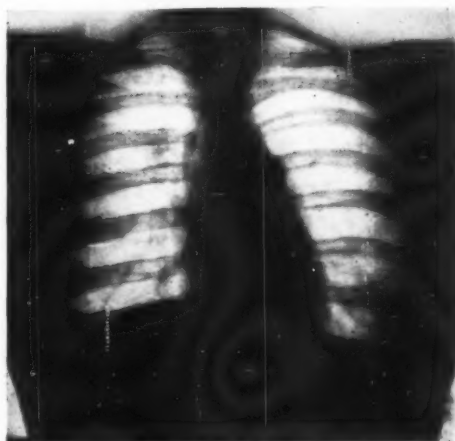
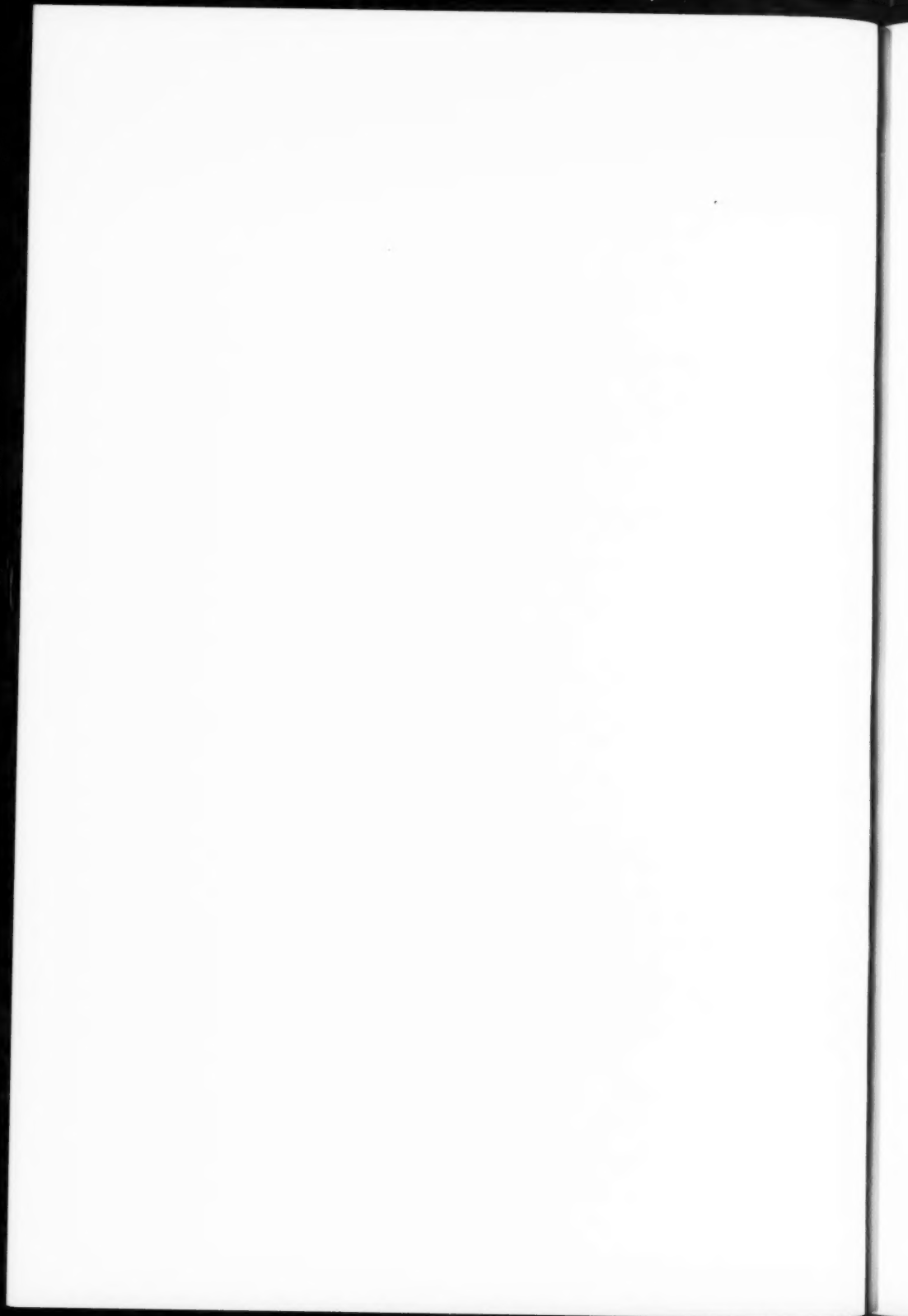


FIG. 2.

To face page 60



very grave state of the patient. No associated vascular lesions of the skin, however, were seen.

The sudden onset of blueness of the lips following upon strenuous pulmonary exertion would seem to be uncommon, as cyanosis arising in association with this syndrome usually comes on gradually and is slowly progressive. There did not seem to be any evidence of marked disability until during the final illness, nor was there any history of outstanding dyspnoea.

The marked exophthalmos was presumably due to "cyanosis retinae."

The spleen was clinically enlarged, but this was of course due to tuberculosis.

One case has already been recorded of this condition which ended fatally with a superadded pneumonia.⁴ There does not, however, seem to be any previous note of arterio-venous aneurysm of the lung with associated pulmonary tuberculosis as found in this patient.

I am indebted to Dr. J. T. Randolph Russell for collecting the details of the history.

REFERENCES

1. BOWERS, W. F. (1936): *Nebraska Med. J.*, **21**, 55.
2. BAKER, CHAS., and TROUNCE, J. R. (1949): *Brit. Heart J.*, **11**, 109.
3. BARNES, C. G., FATTI, L., and PRYCE, D. M. (1948): *Thorax*, **3**, 148.
4. DAVOIR, M., PICOT, G., POLLET, L., and GAULTIER, M. (1939): *Bull. Mém. Soc. Méd. Hôp. Paris*, **55**, 596.

BROMPTON REHABILITATION CLINIC

By NEVILLE C. OSWALD

From the Brompton Hospital, London

TOWARDS the end of 1948 it was decided that a clinic should be formed at which patients could obtain a combined opinion from a member of the visiting staff, an almoner and a Disablement Resettlement Officer (D.R.O.) upon possible future employment. This account deals with the functioning of the clinic and the results of interviews of all patients seen first during 1949; the state of employment of all these patients at March 31, 1950, is known, giving a follow-up of from three to fifteen months. The clinic has been held monthly both at the hospital and at its sanatorium at Frimley. Altogether some 84 patients have been interviewed, on an average of two occasions each, 57 having been first seen at the sanatorium and 27 at the hospital; many of the sanatorium patients have also been seen at the hospital after discharge. Of the 84 patients, all but 5 were suffering from pulmonary tuberculosis: 58 were males and 26 females, ranging in age from 16 to 65.

ASPECTS OF EMPLOYMENT OF ALL PATIENTS DISCHARGED FROM FRIMLEY DURING THE YEAR

The sanatorium has 150 beds and 322 patients were discharged during 1949, after an average stay of rather less than six months.

The patients formed a representative cross-section of the middle and lower income groups; there were no paying patients and major thoracic surgery

was not performed at the sanatorium. Patients were rarely admitted until they were fit to be up for two or three hours a day, the function of the sanatorium being directed to restoring the patients' working capacity by means of a carefully regulated course of graduated exercise. There was some selection of cases in that the majority had a reasonably good prognosis at the time of admission.

Aspects of employment of the 322 patients were as follows:

								<i>Per cent.</i>	
Returned to same employer—									
(a) previous occupation	..	..	..	..	..	..	..	48	15
(b) modified conditions	..	..	..	..	..	..	..	70	22
Found own employment	..	..	..	..	..	..	..	37	12
Returned to housework (women)	..	..	..	..	..	..	..	42	13
Unfit for work	..	..	..	..	..	..	..	52	16
Miscellaneous	..	..	..	..	..	..	..	31	9
Referred to the Rehabilitation Clinic	..	..	..	..	..	..	..	42	13
								322	100

It is evident from these figures that the great majority of patients found suitable employment, if they were fit to work, no less than one-half returning either to a former employer or to housework. Amongst the miscellaneous group of 31, 8 are occupied in full-time studies, 7 went to their local D.R.O. direct without visiting the clinic and have not been placed, 7 are at home and do not need to work, 3 postponed return to work for domestic reasons, 3 discharged themselves from the sanatorium against medical advice, 2 were lost sight of but were not working when last heard of, and one colonised at the sanatorium. There remained a group of 42 (13 per cent.) who sought the advice of the clinic; these, together with a further 15 who were seen at the sanatorium during the year and discharged after December 31, and 27 who were first seen at the hospital during 1949, comprise the total of 84 patients.

CLINIC ROUTINE AND RESULTS

A standard routine was adopted in each case as follows:

- i. An estimate by the visiting physician of the general state of health and prognosis, the radiological extent of the disease, whether tubercle bacilli were demonstrable in the sputum, whether refills were required, and the recommendations of the physician in charge of the case.
- ii. A report from the almoner, including education and previous employment, home conditions and housing, financial position, personality, aptitudes and ambitions.
- iii. An assessment by the D.R.O. (in this case a Group D.R.O.) concerning the availability of suitable employment and possible courses of training or industrial rehabilitation.
- iv. An interview with the patient and after a full discussion a decision made and advice given.

The results of the interview are given in the following table. The total does not agree with the number of patients interviewed, since some were advised to try more than one channel—*e.g.*, to visit their local D.R.O.—and also to try to find employment by their own endeavours.

Referred to local D.R.O. with suggestions as to suitable employment	25
Referred to Government Training Centre or Technical College	12
Referred to Appointments Office for Executive post or training	5
Referred to Remploy Ltd.	1
Referred to course of Industrial Rehabilitations	1
Returned to previous occupation or employer	6
Obtained employment by his own endeavours	7
Obtained training or post arranged direct by the Clinic	5
Decision deferred until health improved	23
	<hr/> 85

Reference to Local D.R.O. for Employment.—Disablement Resettlement Officers were first appointed to Employment Exchanges with the introduction of the Disabled Persons (Employment) Act, 1944, in order to assist in the placement in industry of those who had been accepted as disabled under the meaning of the Act; their work has been to a large extent experimental and their scope cannot as yet be fully defined. They have a special knowledge of the needs of industry and detailed information concerning the various government training schemes; they visit hospitals as requested in order to interview individual patients. The present clinic was set up with a view to establishing a closer liaison between the medical and social staffs in dealing with the resettlement of patients suffering from pulmonary tuberculosis, who comprise about 5 per cent. of all Registered Disabled Persons. A high proportion of the present group were referred to their local D.R.O.'s with suggestions as to suitable employment, after completion of the special form D.P.I.X., a lengthy and unhappily designed booklet which has to be filled in for each case. Of the 25 so referred, 10 have already obtained employment of the type suggested and a further 5 have obtained other suitable employment by this procedure.

Government Training Schemes.—There are now about 70 different courses available for selected unemployed persons, whether or not they are disabled, many being under the direct control of the Ministry of Labour. The subjects cover a wide range, such as commercial subjects, boot repairing, draughtsmanship and carpentry, and the waiting lists vary from a few weeks to several months. For tuberculous patients, they are virtually limited to sputum-negative cases, and this particularly applies to residential courses. Of the 12 patients so referred, 7 have started training and a further 3 are waiting for their courses to begin; one was turned down as failing to reach the required educational standard and one has found other suitable employment.

Appointments Office.—This office deals with persons of higher educational standard, with a view to placing them in executive positions or arranging professional, university or business training. Of the 5 so referred, 3 obtained such appointments or training, and the remaining 2 are waiting for courses to begin. In 3 instances, the Appointments Office was able to give formal approval of the wishes of the patients to enable grants to be made.

Remploy Limited.—This independent organisation, approved by the Ministry of Labour, consists of about 70 factories in various parts of the country, in which severely disabled patients are able to work and earn wages under sheltered conditions. Three of these have been set aside for patients suffering from pulmonary tuberculosis. Open cases are eligible and such a scheme should obviously have the full backing of the medical profession. Unfortunately,

many otherwise suitable patients are disinclined to work alongside their fellow sufferers and, even if they are persuaded to go, tend to leave as soon as they feel they can support themselves in open competition, where they can earn higher wages. There is only one such factory in London, at Bermondsey, and many who might wish to go are precluded from doing so by the journey to and from home. One patient in this series was referred and was accepted.

Industrial Rehabilitation Units.—Several units have now been established with a view to investigating the aptitude of patients who are undecided about their choice of a trade. Such patients, usually at the convalescent stage of an illness or injury, are sent to these units for six to twelve weeks and are shown the various types of work which may interest them, and for which they are considered suitable. Subsequently, they usually obtain suitable employment or proceed to a course of training. Only one patient in this series was referred for such assessment, and is now attending a course in watch and clock repairing. More use will probably be made of these facilities in future in non-infectious cases.

It was the policy at the Clinic to persuade patients to return to their previous employers whenever possible, and often the D.R.O.s were able to arrange suitable employment by approaching the employers, thus establishing a continuity in the trades for which the patients had been trained. Six patients found their own niches, and indeed there remain some with occupations which seem rarely to come within the ambit of the Ministry of Labour, such as receptionists, jeweller's assistants and actors.

In five instances, employment or training was obtained direct from the Clinic, largely on the initiative of the almoner at her preliminary discussions.

Summary.—Of the 84 patients who attended the Clinic during 1949, the position at March 31, 1950, was that 50 had obtained employment or were attending courses, 23 were unfit to start work, and 11 were fit to work but remained unemployed.

Employment of Patients with Positive Sputa.—This has not so far been a major problem in the Clinic. Of the 84 patients interviewed, 14 had demonstrable tubercle bacilli in the sputum. Ten have not yet returned to work, largely because the physicians in charge do not yet consider them sufficiently fit and referred them either for a preliminary interview or at the patient's own request. Of the four who have returned to work, one is running his own pig and poultry farm, one has colonised at Preston Hall, one has started work at a Remploy Factory and one is repairing tapestry. The criteria of a negative sputum have been three negative smears and three negative cultures for the Frimley patients, which are far stricter than the standards which usually obtain in out-patients' clinics, where two or three smears and only an occasional culture have sufficed. For accurate assessment of activity and prognosis, a prolonged search for bacilli is necessary and the Frimley standards are generally recognised as being ideal. From the standpoint of employment patients must be labelled "positive" or "negative," which is interpreted as meaning "infectious" or "non-infectious," so that criteria in the industrial sense are required. In busy clinics and dispensaries, widespread cultural examinations would be impracticable and lead to considerable delays in starting employment, and it is suggested that three smears should suffice. At all events, criteria must be

laid down, because at the present time most forms of employment and courses of instruction are open only to patients who have been declared non-infectious. It should also be emphasised that bacteriological examination is by no means the only criterion of fitness for work; equally important are the clinical and radiological appearances, from which it is possible to judge fairly accurately whether or not a positive sputum is likely to persist or recur. There must be very few clinicians who can tell in a patient, for instance, who has had a thoracoplasty in the past and whose disease now appears to be arrested, that tubercle bacilli will never again be found if they are looked for sufficiently diligently, particularly after a recent cold in the head. It would be unfair to forbid such a patient to work. Moreover, there are many thousands of patients whose sputum is or was at one time positive and who will arrest their disease, live to an old age and die from an unrelated cause. Against these arguments must always be faced the fact that almost all tuberculosis originates from contact with open cases of the disease, some people being more susceptible and some receiving larger doses of bacilli than others. It is only too evident that persons with a familial susceptibility should particularly avoid receiving a large dose of bacilli before the age of thirty, and this equally applies to all children under the age of five. Since there are at present inadequate facilities for isolating the many thousand open cases capable of work, it is far better that these should be placed in suitable employment than that they should be left to their own devices and end, as they usually do, in unsuitable work which is often far beyond their physical capacity. There are considerable variations in prognosis, in degrees of infectivity and in personal hygiene. Chronic open cases with careless habits are best isolated completely from young children and young adults, preferably in one of the existing institutes or organisations specially adapted to receive them. Less dangerous cases can often be found suitable employment as caretakers, timekeepers, etc., the more so since firms with more than twenty employees are obliged to take 3 per cent. of disabled persons. There remains a large group of patients with a reasonably good prognosis, and possibly a trace of sputum which contains tubercle bacilli, who have been trained in a sanatorium to cover their mouths when coughing and dispose of their sputum hygienically. They are aware of their disease and take adequate precautions both for themselves and other people. Such patients must be found useful employment, and in fact the majority do. Those whose misfortune it is to have no job to return to after leaving a sanatorium must be given every encouragement and assistance from D.R.O.s, and courses of training made available for them when necessary. D.R.O's are willing to deal with any case in which the medical certificate (D.P.I.X.) states that the patient is fit for a measure of employment. When there is any question of infectivity, the D.R.O. consults the referring physician with regard to necessary safeguards and the suitability of available jobs. In practice, such cases are rarely referred, and when they are, they are extremely difficult to place, as nearly all employers refuse to accept them unless they are declared to be non-infectious. This inevitably leads to patients finding their own employment without declaring their disability, or "going underground," often in a most unsuitable environment. It is not the present policy in this country to isolate all open cases, indeed it would be wrong to do

so. Hence, those patients who are deemed fit to work must be placed in such a way that the greatest use is made of their capabilities which is compatible with the public health. If objections are raised by fellow workers, personal visits should be, and are, arranged by chest physicians and others to explain the situation in individual cases.

Discussion

The figures presented here are small and do little more than show the various methods of solving such patients' difficulties. The general trend of the clinic at the sanatorium was very different from that at the hospital. The Medical Superintendent was present in person at the meetings and added his assessment of the patients' needs and capabilities. In his opinion the monthly Clinic is of very real value in raising morale and making the patients feel that sanatorium treatment is a preparation for their return to a useful working life. Several patients attended the Clinic at their own request many months before they would be fit for employment. The G.D.R.O. supplied appropriate leaflets and made countless inquiries concerning possible vacancies and courses of training, thus enabling patients to decide upon their future careers, or at least to know the possibilities, before leaving the sanatorium. The patients usually attended the Clinic with an appearance of expectancy and enthusiasm; almost all who were fit for work have been successfully placed.

The atmosphere at the hospital Clinic was quite different. The new patients were for the most part those who had already sought employment through the usual channels and failed. Some, particularly the middle-aged, were so physically or temperamentally handicapped as to be virtually unemployable; indeed, there was a hard core for whom little could be done, unless perchance there was a wife in the background who could assist in a residential post. Several bronchitic patients were so affected by inclement weather that they dared not leave their homes on foggy or damp days and were thus unable to keep their jobs. Others were only fit for part-time work, which is virtually unobtainable in London at the present time. Little has been done as yet in providing simple assembly work which could be done at home, and it would seem both from the point of view of the skill available and the morale of the patients concerned that this aspect should be explored more fully. Resettlement is largely a problem of enabling men to be paid for work done; more than two-thirds of those who attended the Clinic were men, and there was rarely any difficulty in finding suitable employment for women.

I should like to take this opportunity of thanking Miss Coltart, the other Almoners of the Hospital, and Mr. Knowles, Group Disablement Resettlement Officer, for their assistance in running the Clinic. Also the members of the Visiting Staff for their encouragement and comments.

RESULTS OF PNEUMOPERITONEUM IN PULMONARY TUBERCULOSIS

By E. W. THOMPSON EVANS

Abbreviations as used throughout this paper

L.U.Z.: Left upper zone	R.U.L.: Right upper lobe
R.U.Z.: Right upper zone	L.U.L.: Left upper lobe
L.M.Z.: Left middle zone	R.M.L.: Right middle lobe
R.M.Z.: Right middle zone	L.M.L.: Left middle lobe
L.L.Z.: Left lower zone	R.L.L.: Right lower lobe
R.L.Z.: Right lower zone	L.L.L.: Left lower lobe
L.I.H. and R.I.H.: Left and right inguinal hernia	

IN 1931, while attempting to induce a pneumothorax, Banyai accidentally introduced air into the peritoneal cavity, and as the patient's hæmorrhage ceased the pneumoperitoneum was kept up for a time. In 1933 Vadja first considered the value of pneumoperitoneum as a mode of treatment, while in 1934 Banyai noticed that the effect of the pneumoperitoneum could be enhanced by the addition of a phrenic paralysis. In 1938 he reported on a series of 138 cases but did not evaluate the results. Sporadic reports followed, but not until 1941 did Rilance and Warring, with 55 cases, and Fowler, with 56 cases, try to analyse the results.

A survey of the papers published after 1941 gives a picture of the evolution of the treatment. In the early stages pneumoperitoneum was used mainly in advanced cases where no other treatment was possible, and the results, although not impressive, encouraged exploration of further suitable material. In this country the war years retarded research, but the Brompton Hospital statistics indicate the development, viz. 5 cases were treated by pneumoperitoneum in 1944, 17 in 1945, 32 in 1946, 51 in 1947 and 52 in 1948.

The earliest inductions in this series date from February 1945, that is in the pre-chemotherapy era, and at a time when chest physicians were seeking personal knowledge of this new treatment. Many cases were induced which, in the light of later experience, were unsuitable, but, nevertheless, the results are recorded. Furthermore, the advent of streptomycin and P.A.S. has, in recent years, dulled the enthusiasm for pneumoperitoneum, but, on the other hand, many patients to-day owe their recovery to this treatment alone.

Total number of cases, 120 (51 males, 69 females).

Mode of Treatment

Pneumoperitoneum alone	30 cases (12 males, 18 females)
Pneumoperitoneum plus right phrenic crush (R.P.C.)	51 cases (28 males, 23 females)
Pneumoperitoneum plus left phrenic crush (L.P.C.)	39 cases (11 males, 28 females)

Age at induction varied from 13 to 55.

Age				Females	Males	Totals
13-15	..	..	..	1	1	2
16-20	..	..	..	9	3	12
21-25	..	..	..	11	9	20
26-30	..	..	..	21	12	33
31-35	..	..	..	13	6	19
36-40	..	..	..	4	11	15
41-45	..	..	..	7	4	11
46-50	..	..	..	2	2	4
51-55	..	..	..	1	3	4
				69	51	120

The conduct of treatment is summarised in the following table:

Length of P.P. in Months	P.P. Abandoned				Treatment Completed		P.P. Continuing	
	Died during P.P.	Died Later	No Other Treatment	Other Treatment Available	P.P. Therapy Alone	P.P. to Later Surgery	Awaiting Surgery	Sole Therapy
Up to 6	—	5	1	3	—	—	—	—
7-12	—	6	1	1	—	1	—	—
13-18	—	2	2	2	—	1	—	—
19-24	1	2	2	3	—	3	—	—
25-30	1	5	2	1	—	2	—	—
31-36	—	—	1	1	—	3	5	—
37-42	—	—	—	—	3	—	4	13
43-48	—	—	1	—	2	2	5	9
49-54	—	—	—	1	—	—	—	13
55-60	—	—	—	—	1	—	1	6
61-65	—	—	—	—	—	1	—	1
TOTALS	2	20	10	12	6	13	15	42
	18%		8%	10%	5%	11%	12.5%	35%

The pneumoperitoneum was abandoned in 44 cases, *i.e.* 37 per cent., for the following immediate reasons:

Deaths during pneumoperitoneum	..	..	2
Spread:			
Pulmonary, 16	}	.. .. .	18
Systemic, 2			
Clinical deterioration	..	.. .. .	4
No effect on the cavitation	..	.. .. .	5
Bronchopleural fistula	..	.. .. .	2
Severe dyspnoea	..	.. .. .	2
Large peritoneal effusions	..	.. .. .	5
Change to A.P.	..	.. .. .	4
Incisional hernia, acute onset	..	.. .. .	1
Uncontrollable left inguinal hernia	..	.. .. .	1

The details of the four individual tables where pneumoperitoneum was abandoned are as follows:

(1) *Died during Treatment.*—Two cases died of a massive hæmoptysis during the course of the pneumoperitoneum, females aged 29 and 32 respectively, both

with R.U.L. cavitation, failed A.P.s., accepted for and awaiting thoracoplasty, and with pneumoperitoneums and right phrenic crush for 20 and 25 months. Both patients had good rises of the right dome of $8\frac{1}{2}$ cm. (43 per cent.) and 13 cm. (62 per cent.) respectively.

These illustrate how in some cases upper lobe cavities may be quite uninfluenced despite excellent relaxation from below.

(2) *Died at a Later Date.*—

<i>Sex</i>	<i>Age</i>	<i>Duration of P.P. in Months</i>	<i>Type of Lesions</i>	<i>Reason for Abandonment of Pneumoperitoneum</i>
F.	46	10	Fibrous cavities L.U.Z. Infiltration R.	Generalised spread to larynx, kidneys, intestines (pneumo-coele of diaphragm).
F.	42	12	3 cm. thick-walled cavity R.U.L. plus fibrotic infiltration. Cavities L.U.Z.	No effect.
F.	40	6	Tension cavity R.U.L. Cavities L.U.Z.	Clinical deterioration. Poor rise of domes.
F.	34	13	Chronic fibrotic disease in both U.Zs. Cavities L.U.Z.	Clinical deterioration.
F.	34	27	Two R.U.L. cavities within fibrotic infiltration. Cavitation L.M.Z.	Right bronchopleural fistula.
F.	30	9	Thick-walled cavity L.U.Z. Infiltration R.U.L.	Bronchopleural fistula.
F.	29	27	Bilateral broncho-pneumonic.	Failed eventually to prevent cavitation and clinical deterioration.
F.	28	13	3 cm. cavity L.U.Z.	Progressive basal cavitation and endobronchitis.
F.	27	6	Advanced bilateral lesions. Two cavities R.M.Z.	Clinical deterioration. Spread to larynx and intestines.
F.	26	28	Upper zone cavities R. and L. Heavy infiltration L.	Progressive clinical deterioration.
F.	23	24	Cavity R.M.Z. Heavy infiltration on L.	Clinical deterioration. Spread. Cavitation in all zones.
F.	20	23	Cavitation L.U.Z. Infiltration R.U. and M.Z.s	Spread and cavitation R.U.L. and L.M.Z.
F.	16	26	Coarse miliary lesions and cavities both upper zones.	Clinical deterioration. Further cavitation.
M.	48	9	Small thick-walled cavities and fibrotic infiltration both upper zones.	No effect. Progressive cavitation.
M.	45	12	Ditto.	Sudden clinical deterioration. No effect on cavities.
M.	30	9	Thick-walled cavities R.U. and M.Z.s	Progressive spread.
M.	27	4	L.U.Z. cavitation within fibrotic infiltration. Infiltration R.U. and M.Z.	Progressive spread.
M.	22	6	Cavitating "tuberculoma" R.L.Z.	Progressive spread throughout both lungs.
M.	16	6	Cavity L.U.Z. L.A.P. with later tuberculous empyema.	Progressive spread.
M.	13	25	Fibro-caseous lesions both upper and mid-zones with bilateral cavities. Endobronchitis	Progressive spread and clinical deterioration.

Review of these cases shows:

- (a) The uselessness of pneumoperitoneum for thick-walled cavities, lying within fibrotic infiltration, where the lesions show chronicity. The degree of contractility of diseased lung tissue depends on the type of disease, the proliferative and exudative type contracting more easily than the fibrotic type. Pinner (1928) states scar tissue will contract so long as it is being actively formed, but when it becomes hyalinised it ceases to contract. Thus, old-standing fibrotic lesions will not benefit from upward mechanical relaxation.
- (b) The closure of upper lobe cavities is always speculative, more so if they are bilateral or of the fibrous wall type, or the tension type with an endobronchial element. The reasons are discussed under cavity closure.
- (c) Advanced disease. A pneumoperitoneum must not be "the refuge of the therapeutically destitute." Alone it is useless in advanced disease, except for possible clinical amelioration, but this is mainly temporary. Many of these cases, in the light of further experience, would not to-day have been induced. In those early days one often expected a pneumoperitoneum to achieve what some expect chemotherapy to do to-day. There will be similar disappointments in the advanced cases.

(3) *Pneumoperitoneum abandoned. No Other Treatment contemplated.*—Cases in this class fall into the following categories:

- (a) Duration of pneumoperitoneum cut short by complications (2, 2½, 4 years), but during the period of observation (12, 18, 20 months) the end result has been good: 3 cases.
- (b) Pneumoperitoneum made some contribution in arresting some of the lesions, as, after abandonment due to complications, spontaneous retrogression of the residual lesions occurred: 2 cases.
- (c) Pneumoperitoneum made no contribution to later spontaneous retrogression following abandonment due to complications: 1 case.
- (d) Pneumoperitoneum no value at all and prognosis now bad. One case with dorsal lobe cavities, 1 with bilateral fibrotic upper lobe cavitation, 1 with a large L.U.Z. tension cavity and 1 with fibrotic upper zone cavitation: 4 cases.

(4) *Pneumoperitoneum abandoned. Other Modes of Treatment Feasible.*—Cases here fall into the following categories:

- (a) Pneumoperitoneum to "cool down" acute lesions, thus allowing later pneumothoraces to be induced with safety: 3 cases.
- (b) Pneumoperitoneum of some value, but duration cut short by complications. Surgery was possible later: 3 cases.
 - (i) Pneumoperitoneum closed a R. dorsal lobe and L.U.Z. cavity for 2½ years, but was abandoned owing to a large peritoneal effusion. Within a month the dorsal lobe cavity reopened, and the patient is now awaiting surgery.
 - (ii) Pneumoperitoneum closed a R.L.Z. cavity and a superadded

L.A.P. closed a L.U.Z. cavity. Non-specific pneumonia caused respiratory distress and abandonment of the pneumoperitoneum. L.U.Z. cavity reopened and A.P. abandoned. Now awaiting surgery.

- (iii) Pneumoperitoneum abandoned owing to a large painful uncontrollable L.I.H. It had cleared infiltration in L.U.L. A thick-walled R.U.L. cavity was untouched. Awaiting surgery.
- (c) Pneumoperitoneum ineffective from onset owing to complete symphysis between the liver and the R. dome, with immediate massive peritoneal effusion. L.U.L. cavity awaiting surgery: 1 case.
- (d) Pneumoperitoneum no value; awaiting surgery: 4 cases.
 - (i) L.U. and M.Z. cavitation. No response.
 - (ii) Thick-walled R.U.L. cavity. No response in 2 cases.
 - (iii) Bilateral upper zone cavities. No response. R. closed by A.P. L. awaiting thoracoplasty after contraselective L.A.P.
- (e) Inexplicable breakdown: 1 case.
Tuberculous bronchopneumonia of all zones with R.U.L. cavity. Pneumoperitoneum and R.P.C. closed the cavity within 3 months, with arrest of the other lesions. The cavity remained closed for 4 years 4 months, with negative cultures and tomographic control. Sudden reopening of cavity. R.A.P. induced.

Cases who have completed Treatment

M. et. 36.—1 cm. cavity L.U.Z. with infiltration throughout rest of lung. L.A.P. but poor collapse with mediastinal, apical and lateral adhesions. L.P.C. added, but poor rise, and pneumoperitoneum also added, with $7\frac{1}{2}$ cm. rise of L. dome. Cavity closed, and after 3 years L.A.P. practically obliterated. Infiltrations cleared and pneumoperitoneum completed after 5 years. Pneumoperitoneum had supplemented a poor A.P.

F. et. 18.—Spinal lesions of L. 3 and 4, with paravertebral abscess. Four small cavities in R.U.L. with a $\frac{1}{2}$ cm. cavity L.U.Z. with infiltration L.M. and L.Zs. Pneumoperitoneum for $3\frac{1}{2}$ years. Cavities closed with progressive fibrosis and calcification. Owing to the spine she had nearly 2 years of bed rest, and this undoubtedly contributed to the healing of the lesions, but within 6 months of the pneumoperitoneum gastric lavage gave negative cultures.

M. et. 27.—Infiltration only R.U.L., L.U. and M.Zs. Positive G.W.O. P.P. and L.P.C.; the latter lasted 18 months and was not recrushed. Pneumoperitoneum for 4 years. All lesions healed.

M. et. 18.—Bilateral pleural effusions with infiltration of L.U. and M.Zs. Sputum positive. Pneumoperitoneum for $3\frac{1}{2}$ years. Lesions healed.

F. et. 21.—Infiltration R.U. and M.Zs. and L.M.Z. Sputum positive. R.A.P. contraselective and abandoned. Pneumoperitoneum and R.P.C. for 4 years. Lesions healed.

M. et. 40.—Infiltration R.U. and M.Zs. Sputum positive. R.A.P. failed. P.P. plus R.P.C. for $3\frac{1}{2}$ years. Lesions healed.

The last 4 cases illustrate, as is shown later, the value of pneumoperitoneum where there are infiltrations only, yet positive findings were obtained. The period of follow-up after cessation of treatment has been relatively short, but all cases have remained healed. The first 2 had cavities, 1 case combined with an A.P., the other P.P. alone, but she also had 2 years of bed rest.

Cases who have had Surgery.—Thirteen cases had their refills continued until thoracoplasty was performed. They fall into two classes:

- (a) Upper zone cavitation with infiltration in other zones of the same lung, or contralateral lung: 9 cases. (A.P. had failed or was contraselective in 6 cases.)
- (b) Cavitation and infiltration in one lung where A.P. had failed or was contraselective: 4 cases.

The value of the pneumoperitoneum in making a patient fit for surgery lay in the retrogression and arrest of the infiltrations. In the bilateral cases control was obtained on the lung opposite to the cavitation, while in the same lung as the cavitation infiltrations retrogressed, and often reduced the extent of the surgery. The thick-walled cavities rarely showed much change. Mitchell (1947) found the average time necessary to make a patient with a pneumoperitoneum fit for surgery was 79 weeks. Chemotherapy has now considerably reduced this period.

In some cases the pneumoperitoneum was induced where the lesions were too acute for an A.P. to be considered and where the latter failed or was contraselective. The pneumoperitoneum was kept up during this trial period. The presence of a pneumoperitoneum is not an absolute safeguard in unilateral cavitation and infiltration, as in other cases uncontrollable spread to the opposite lung has been observed during treatment. Fortunately to-day we have other means of controlling this. The long periods of refills were dependent, not on the time for the infiltrations to become inactive, but on the availability of surgery, for often cases had to wait as long as 2 years. Many patients were able to resume employment during the waiting period.

Cases awaiting Surgery.—These cases fell into three groups, (a) and (b) as in the preceding paragraphs:

- (a) 9 cases. A.P. failed or contraselective in 4.
- (b) 5 cases. A.P. failed or contraselective in 4, the remaining case being a diabetic.
- (c) Cavitation in both upper zones, that on the R. closing with the pneumoperitoneum and that on the L. awaiting thoracoplasty. This unfortunately was a rare case.

Three cases in this group were diabetics, 2 under category (a), 1 under category (b). Their prognosis was materially altered with pneumoperitoneum therapy.

It was felt that pneumoperitoneum was a valuable preparatory measure for subsequent surgery, even if it was not an absolute safeguard against relapse.

Types of Lesions

Infiltrations.—Eleven cases of non-cavitating lesions were treated, 6 by pneumoperitoneum alone, 4 with a superadded R.P.C., and 1 with a L.P.C. All had positive sputa or gastric lavage. Eight cases had bilateral lesions, 3 unilateral lesions, the infiltrations in both classes being distributed in all six zones. A.P. failed in 4 predominantly unilateral cases; 1 case was acute in nature, 1 had unilateral basal infiltrations, 1 bilateral case was aged 47, and 4 cases were induced solely on account of the bilateral nature of the lesions.

The results in this group were excellent. All showed permanent sputum

conversion with healing of the lesions, whatever the site. Four of the cases have completed their treatment and there has been no recurrence in varying periods of observation up to 2 years. One case had refills abandoned after 25 months because of complications but has shown no further activity over the past 2 years.

Trimble (1947) considers pneumoperitoneum therapy almost specific for bilateral infiltrations without cavitation. It will avoid long periods of bed rest if healing by natural processes is contemplated; it can, moreover, with safety be induced at home soon after diagnosis, and the patient will be spared possible cavitation.

Some cases continue refills because of various factors, such as family commitments, type of patient, etc. In many such it is felt refills can safely be completed after 3 years.

Cavities.—In this series 157 cavities were found in the 109 patients with cavitation; these include cavities present before induction or developing during refills. They were distributed as follows, and treated by the methods shown. The zonal description of cavities is in accordance with the skiagraphic terminology of the J.T.C., 1939, and has been adopted as lateral views were not taken in the early cases. The mid-zone cavity is usually in the dorsal segment of the lower lobe.

	R.			L.			Totals
	Upper	Mid.	Lower	Upper	Mid.	Lower	
P.P.	20	3	—	21	7	2	53
P.P. + R.P.C.	40	8	7	8	3	—	66
P.P. + R.P.C. + L.A.P.	—	1	—	1	—	—	2
P.P. + L.P.C.	2	—	—	17	10	3	32
P.P. + L.P.C. + L.A.P.	—	—	—	1	1	—	2
P.P. + L.P.C. + R.A.P.	1	—	—	1	—	—	2
TOTALS	63	12	7	49	21	5	157

Complete closure of all cavities with sputum conversion was obtained in 40 cases out of the 109, *i.e.* 36.7 per cent. In these 40 patients, 48 cavities were closed out of the 157, *i.e.* 30.5 per cent., in the following sites:

	R.			L.			Totals
	Upper	Mid.	Lower	Upper	Mid.	Lower	
P.P.	4	1	—	3	—	—	8
P.P. + R.P.C.	11	4	5	—	—	—	20
P.P. + R.P.C. + L.A.P.	—	1	—	1	—	—	2
P.P. + L.P.C.	1	—	—	5	5	3	14
P.P. + L.P.C. + L.A.P.	—	—	—	1	1	—	2
P.P. + L.P.C. + R.A.P.	1	—	—	1	—	—	2
TOTALS	17	6	5	11	6	3	48

In addition 14 cavities closed during treatment among patients in whom another cavity elsewhere remained patent, so that total arrest of the disease or sputum conversion was not achieved. The distribution of these odd cavities which closed is interesting, and is as follows:

	<i>R.</i>			<i>L.</i>		
	<i>Upper</i>	<i>Mid.</i>	<i>Lower</i>	<i>Upper</i>	<i>Mid.</i>	<i>Lower</i>
P.P.	—	—	—	—	—	—
P.P. + R.P.C.	7	2	—	—	1	—
P.P. + L.P.C.	2	—	—	—	2	—

Two R.U.Z. cavities closed with a L.P.C. and 1 L.M.Z. cavity closed with a R.P.C., thus illustrating the bilateral relaxation of a pneumoperitoneum on the contralateral side to the paralysed dome. This was frequently seen in cases with unilateral cavitation and bilateral infiltration; there was clearing of the infiltration on the opposite side to the paralysed dome. The factor of spontaneous cavity closure and retrogression of infiltration has not been disregarded in assessing results.

Cavity closure in the upper zone is comparatively poor, owing in the first place to the high incidence of upper-zone cavities, and also to lessened compression on this area from a pneumoperitoneum. In addition, in this area pleural adherence plays a large part. The nearer the cavity is to the apex the less the surrounding lung tissue and the more the pleura is involved. Failure to close upper lobe cavities has been striking in two types:

- (a) The old-standing thick-walled cavity, often surrounded by fibrotic infiltration, whose fibrous walls have lost the power of contractility.
- (b) The thin-walled tension type, where endobronchial lesions play an important part.

Measurements of the apico-basal diameter showed the following averages. The percentage figures are necessary to avoid errors due to variation in the size of the thorax.

	<i>R. Dome</i>	<i>L. Dome</i>
P.P.	5.7 cm. (25%)	5.3 cm. (22%)
P.P. + R.P.C.	8.6 cm. (36%)	4.7 cm. (17%)
P.P. + L.P.C.	4 cm. (18%)	7.6 cm. (30%)
<i>Maximum rises were:</i>		
P.P.	10 cm. (55%)	11 cm. (42%)
P.P. + R.P.C.	13 cm. (62%)	4.5 cm. (20%)
P.P. + L.P.C.	6.5 cm. (26%)	15 cm. (55%)

It made no difference to the total rise whether the pneumoperitoneum was done first and the phrenic crush later, or vice versa. A greater average rise occurred of the right dome than of the left, namely 36 per cent. to 30 per cent.

In cases where the lesser fissure was visible, measurements were made of the contraction of the lobes on the right side, with the following averages:

	In Centimetres			Percentages	
	Upper	Mid. and Lower	Total	Upper	Mid. and Lower
After P.P. alone	2	2.9	4.9	37	63
After P.P. + R.P.C.	2.68	4.6	7.28	41	59
After P.P. alone in healthy lung	1.25	4.5	5.75	22	78

This suggests that in a healthy right lung the mechanical compression exerted by a pneumoperitoneum is mainly on the lower zones, *i.e.* the mid- and lower lobes, and less is transmitted to the upper lobe. When areas are diseased, however, they contract more easily. Thus, with a R.U.L. lesion, where the mid- and lower zones are healthy, it is more difficult for compression to be exerted on the upper lobe, but it needs relatively less force to compress it.

In general, compression from below the dome acts on the mid- and lower zones with 63 per cent. contraction compared with the upper lobe contraction of 37 per cent. If the dome is paralysed, the upper lobe contracts only another 4 per cent., although the total contraction of the whole lung is much increased.

Mid-zone Cavities.—These are usually dorsal lobe cavities, lying posteriorly and often widely adherent to the pleura. A pneumoperitoneum alone gave poor results, but they were in advanced cases. In cases with additional phrenic crush, 45 per cent. were closed.

Lower zone Cavities.—Again pneumoperitoneum alone was insufficient to close two basal cavities. With phrenic crush added, 75 per cent. of all basal cavities were closed. Two cases with cavities in the posterior basic segment were unaffected, as in this situation they lie in the posterior costophrenic angle, where the dome is attached at a lower level posteriorly than anteriorly. Upward pressure only compresses the cavity to the posterior wall.

During treatment in 1 case, a mid-basic segment atelectasis occurred, and later cavitated. A stout subdiaphragmatic adhesion was attached to this area, and increased rise of the dome caused localised downward peaking of the dome and enlargement of the cavity. Following abandonment of the pneumoperitoneum the cavity gradually closed spontaneously.

In another 2 cases small thin-walled basal cavities appeared during treatment, but disappeared again after 1 and 3 months respectively. Temporary kinking of the bronchus was assumed to be the cause.

A final case, with L.U.Z. cavitation during the pneumoperitoneum, developed basal cavitation which was progressive and led to abandonment of the pneumoperitoneum.

Clifford Jones (1943) and Fraser (1950) found previous pleurisy or effusions prevented an adequate rise of the domes. Out of 25 cases with previous pleural involvement—effusion, empyema, or hydropneumothorax—20 had elevations from 21 to 45 per cent. The time factor played no part, as good rises were obtained where effusions had occurred many years previously, with periods varying up to 15 years. Pleural symphysis was demonstrated in some of the cases, in that A.P.s. had failed.

Duration of the Treatment.—As many of the previous results have been

coughed in indefinite terms of varying degrees of improvement, it is difficult to find any statistics, and comparisons must be made with artificial pneumothorax treatment. It is felt that pneumoperitoneum should be kept up for 3 years in non-cavitating lesions, and in cavitating lesions for 5 years from the time the cavity closes and remains closed. One case had R. dorsal lobe cavity closure for $2\frac{1}{2}$ years, with close sputa and tomographic control, but when the pneumoperitoneum was abandoned following a peritoneal effusion the cavity opened up within a month. A second case had a R.U.L. cavity closed for 4 years, which suddenly reopened. A third case had a R. dorsal lobe cavity closed for $4\frac{1}{2}$ years, yet a new cavitating lesion appeared within the R.U.L. during treatment. It is important to keep the paralysed diaphragm at a constant high level and recrunch the nerve as soon as it regenerates.

General Summary of Results

TOTAL NUMBER OF CASES TREATED, 120

Healed or Arrested Lesions, 51, that is 42.5 per cent.

(a) Treatment completed:				
Non-cavitating lesions, 4	}	..	..	6
Cavitating lesions, 2		..	..	7
(b) Non-cavitating lesions arrested		..	..	7
(c) Cavitating lesions arrested		..	..	38
P.P. alone, 4				
P.P. + R.P.C., 18				
P.P. + R.P.C. + L.A.P., 1				
P.P. + L.P.C., 13				
P.P. + L.P.C. + L.A.P., 1				
P.P. + L.P.C. + R.A.P.				

Improved, 35, that is 29.2 per cent.

Made fit for surgery	..	..	..	..	28
Already had surgery, 12					
Awaiting surgery, 16					
Reduced activity to enable A.P. to be done	..	..	..	..	5
Refills for limited period. Abandoned owing to complications, but did some good in that time	..	..	..	..	2

Failure of Treatment, 34, that is 28.3 per cent.

Died	..	..	..	..	..	22
Worse, prognosis bad	..	..	..	..	..	6
No value, but other treatment possible	..	..	..	..	..	6

In assessing results due attention must be given not only to the 42 per cent. arrested lesions, but to the important class where the pneumoperitoneum enabled a later A.P. to be done more safely, and to those cases made fit for surgery, a total of 29 per cent. The pneumoperitoneum had been of value, therefore, in 72 per cent. of cases.

The present enthusiasm for chemotherapy has reduced the number of pneumoperitoneum inductions, but it is felt there is still wide scope for it, even combined with chemotherapy, provided it is decided before induction what part the pneumoperitoneum is to play in the proposed treatment scheme, and if an objective is set. If it fails to reach this, the pneumoperitoneum should be abandoned and not kept up indefinitely to raise unduly the patient's hopes. At induction the patient should be informed of this. As sputum conversion

occurred in 1 to 6 months, the average time being 3 months, it should likewise be decided early, in any case within 6 months, the value the pneumoperitoneum is likely to have.

The foundation of this paper is based on an M.D. thesis accepted in 1948.

I wish to express my sincere thanks to my late senior colleague, Dr. D. G. Madigan, Consultant Chest Physician, Bromley and Farnborough Hospitals, and to Dr. M. Price, of the Chislehurst Chest Clinic, for the recent follow-ups of many of these cases.

REFERENCES

- BANYAL, A. L. (1946): *Pneumoperitoneum Treatment*. Kimpton, London.
 BROMPTON HOSPITAL REPORTS (1944-1948).
 CLIFFORD-JONES, E. (1943): "Pneumoperitoneum in the Collapse Therapy of Pulmonary Tuberculosis," *Tubercle*, **24**, 98.
 FOWLER, R. O. (1941): "Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis," *Amer. Rev. Tuberc.*, **44**, 474.
 FRASER, J. W. (1950): "Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis," *Brit. J. Tuberc.*, **44**, 31.
 MITCHELL, R. S. (1947): "Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis," *Amer. Rev. Tuberc.*, **55**, 4.
 PINNER, M. (1928): "The Cavity in Pulmonary Tuberculosis," *Amer. J. Roentgenol.*, **22**, 518.
 REPORT ON SKIAGRAPHIC TERMINOLOGY IN PULMONARY DISEASE, J.T.C., 1939.
 RILANCE, A. B., and WARRING, F. C. (1941): "Pneumoperitoneum supplementing Phrenic Paralysis," *Amer. Rev. Tuberc.*, **44**, 323.
 TRIMBLE, H. G. (1947): "Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis," *Dis. of Chest*, **4**, 13.
 VADJA, L. (1933): "Can Pneumoperitoneum be used in the Treatment of Pulmonary Tuberculosis?" *Ztschr. f. Tuberk.*, **67**, 371.

MASSIVE HÆMOTHORAX IN ARTIFICIAL PNEUMOTHORAX TREATED WITH STREPTOKINASE

By R. G. GAULD AND JAMES T. HAROLD

(From the Brompton Hospital)

ASPIRATION of blood from the pleural cavity is often hindered or made impossible by clots. To avoid a frozen lung in that event no measure short of pleural decortication by open thoracotomy is likely to be successful, and even that is liable to be followed by pleural symphysis. Recently Tillett, Sherry and Christensen^{1,2} have reported the use of enzymes injected intrapleurally to liquefy the protein fractions of clotted hæmothoraces and empyemata. These enzymes were prepared by Christensen³ from Group A α -hæmolytic streptococci and termed Streptokinase and Streptodornase, the former liquefying fibrin and the latter nucleoprotein. For the treatment of uninfected clotted hæmothorax a total injection of 200,000 units of Streptokinase is recommended. Streptodornase is usually present in the vials, and while not essential for uninfected hæmothorax, its presence is not contraindicated. Injection of the enzymes into two or three different sites is recommended, followed by aspirations when the liquefaction and outpouring of serum reaches a maximum in twenty-four to forty-eight hours. In most cases

the injection is followed by a febrile reaction similar to other foreign protein reactions. The temperature rises after six hours and as a rule persists for two or three days, occasionally up to a week. It is usually $101-103^{\circ}$ but may reach 105° . In addition there may be symptoms of chilliness, headache, malaise, chest discomfort and arthralgia, which are readily relieved by ordinary analgesics.

We have recently had an opportunity to treat a patient with a clotted hæmothorax by Streptokinase, and we thought it worth while to report our experience of the method.

Case Report

The patient was 24 when first diagnosed as suffering from pulmonary tuberculosis in November 1948. For two years previously he had nursed open cases of tuberculosis and routine chest radiograms were normal during that time. In November 1948 he developed pain in the right side of his chest, bilateral apical infiltration was found and tubercle bacilli were isolated from his sputum. He was admitted to a sanatorium, where he was treated by rest in bed and bilateral artificial pneumothorax. Adhesions were divided on both sides uneventfully, and a free lung obtained on both sides. His sputum contained no tubercle bacilli after July 1949, and after nine months at the sanatorium he was discharged to attend the Brompton Hospital for weekly refills.

On March 13, 1950, he received bilateral refills comparable in every respect to those given in previous weeks. At the time of the refills nothing unusual was noticed by the patient, but while walking home he noticed pain in the left side of his chest and felt weak. These symptoms steadily increased and he was brought to hospital by ambulance two days later. On admission he was pale, shocked, dyspnoëic and seriously ill. There were physical signs of a left hæmo-pneumo-thorax, and fluoroscopy showed fluid, level with the second rib anteriorly. He was treated by blood transfusion and frequent aspiration of air and blood from the left pleural space. The bleeding continued, however, and for two days his condition was critical. After three days he began to improve, but the local condition in the chest remained unsatisfactory. During his first week in hospital he received 9 pints of transfused blood and 86 oz. of heavily-bloodstained fluid were aspirated from his chest, the aspirations becoming progressively more difficult because of clots. Radiograms taken ten days after the refill on March 24 (Figs. 1 and 2) showed a considerable amount of fluid remaining in the pleural space, and it had evidently clotted. At this point thoracoscopic aspiration and thoracotomy with pleural decortication were both considered, but it was felt that the former was unlikely to succeed and that thoracotomy was a risky procedure on account of his general condition. A supply of Streptokinase sufficient for the treatment of one case was available, and it was felt the patient was in every way suitable for its trial.

On March 27, two weeks after bleeding began, a preliminary trial aspiration was made at two sites, but only 2 c.c. of fluid could be withdrawn. A solution of enzymes was then prepared containing 180,000 units of Streptokinase and 63,000 units of Streptodornase in 10 c.c. of sterile saline. The enzymes were then injected into the left pleural space at the anterior axillary line. There was no immediate reaction, but during the next twelve hours the patient's temperature rose to 103° and he complained of intense discomfort in the chest. Next day aspiration was attempted seventeen hours after the injection. Twenty-six ounces of dark brown fluid were withdrawn without difficulty. On the two following days 24 and 10 ounces were similarly withdrawn. On

PLATE VII.

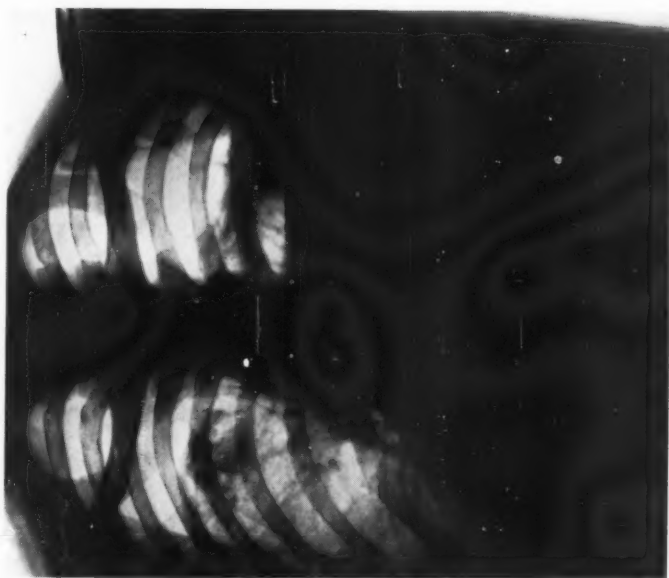


FIG. 1.

PA and L. Lateral Chest X-Rays of March 24th: showing left

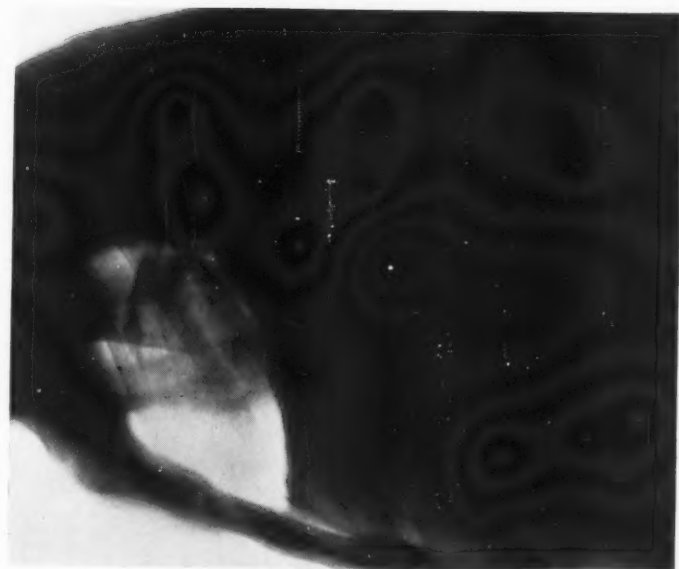


FIG. 2.

Hemothorax persisting after 82 oz. had been evacuated and further aspirations failed on account of clots.

PLATE VIII.

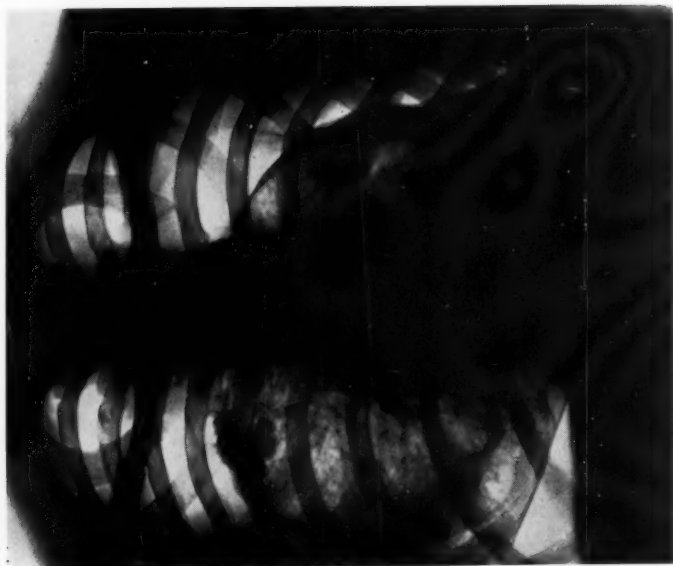


FIG. 3.

PA and L. Lateral Chest X-Rays of April 18th; showing end-result after the use of Streptokinase followed by further aspirations.

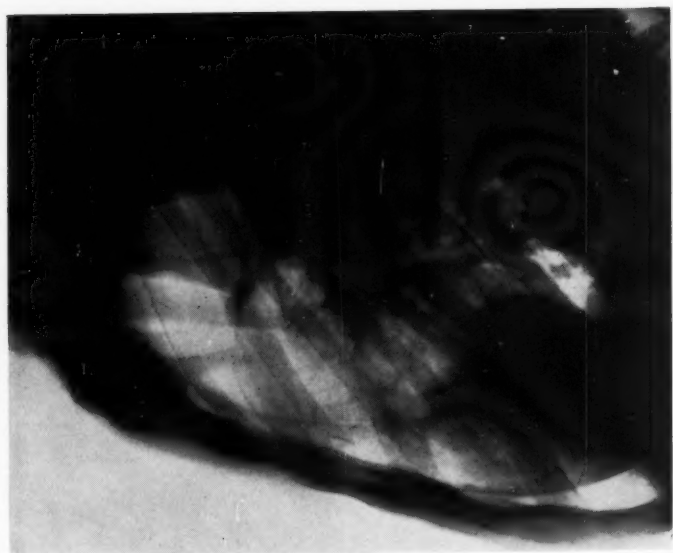


FIG. 4.

March 30 a second similar dose of enzymes was injected into the left pleural space in the posterior axillary line, with less general reaction than on the first occasion. On the three days following this second injection 31, 11, and 18 ounces of brown fluid were aspirated without difficulty. By April 12 a total of 132 ounces of fluid had been aspirated following the two injections of enzymes. But although there was much less fluid in the chest, fluoroscopy showed there was no aeration of the left lung, and while it was felt that the enzymes had successfully dealt with the clots, it seemed that pleural decortication would still be required for a frozen lung.

One week later, however, fluoroscopy showed (Figs. 3 and 4) that the fluid had almost completely absorbed and that the lung expanded 2 inches on inspiration. He resumed his usual weekly refills seven weeks after the onset of his hæmothorax, and was discharged from hospital after a stay of two months. A radiogram taken in July showed little change compared with those taken before the hæmothorax.

Summary

An example is reported of massive clotted hæmothorax treated by Streptokinase. The favourable result confirms American experience. It is likely that this or similar enzymes will come into general use for the treatment of such cases.

We are grateful to Dr. Neville Oswald and to Mr. O. S. Tubbs for encouragement and permission to publish this case; and to Mr. C. Price Thomas for kindly giving the enzymes.

REFERENCES

1. TILLET and SHERRY (1949): *Jnl. Clin. Invest.*, **28**, 173.
2. CHRISTENSEN (1949): *Jnl. Clin. Invest.*, **28**, 163.
3. TILLET, SHERRY, CHRISTENSEN *et al.* (1950): *Annals of Surgery*, **131**, 12.
4. *The Lancet* (1950), **1**, 629.

REVIEWS OF BOOKS

Penicillin. By Prof. Sir ALEXANDER FLEMING, M.B., B.S., F.R.C.P., F.R.C.S., F.R.S. Second edition. Pp. 471. London: Butterworth and Co., Ltd. 1950. Price 30s.

The scope and methods of penicillin therapy change so rapidly that the appearance of the second edition of this book is most welcome. The chapters, which cover the history, chemistry, bacteriology and practical applications, are written by experts in each field, under the editorship of Prof. Fleming. This necessarily involves some repetition, but also shows clearly that modes of treatment are not yet stereotyped. Most contributors agree, however, that procaine penicillin is likely to supersede other preparations. New chapters have been added on drug sensitivity and on the newer antibiotics. Most medical practitioners now use penicillin, and this book is an invaluable guide to its most effective applications. It is well produced and is freely illustrated.

G. M.

Nutritional Data. By HAROLD A. WOOSTER, Jr., and FRED. C. BLANCK. Mellon Institute, Pittsburgh, Penna., U.S.A. First Edition, 1949. 120 pages. Obtainable gratis from the publishers.

This booklet contains a mass of information about human food requirements and composition set out in easily comprehensible tables. The first

half describes the chemical structure of the three main classes of foods and of the vitamins, with short notes about the processes involved in their metabolism. The second half is devoted to analytical composition tables of all foods used in the ordinary kitchen, including the products of the Heinz Company. The figures in these tables are for the most part those recognised by the U.S. departments of agriculture and public health and have been recently revised in the light of new methods of assay. The chief value of the publication is in this half, and it will form a useful reference for all who are responsible for supervising feeding in institutions, particularly where special groups such as children are being cared for.

J. J. Y. D.

Industrial Health. An introduction for Students. By R. PASSMORE, M.A., D.M., F.R.S.E., and CATHERINE N. SWANSTON, M.R.C.S., L.R.C.P., D.P.H., D.I.H. E. and S. Livingstone Ltd., Edinburgh. Pp. 110. Price 4s. 6d.

This small book gives a lucid description of some of the physiological and psychological problems connected with the maintenance of health and efficiency in industry. Disease and accidents are considered largely from the preventive aspect. The book should prove of equal value to students of economics and science, industrial nurses, medical students and those who are responsible for personnel in industry.

G. M.

NOTICES

COURSE ON REHABILITATION

It is proposed to hold a course on Rehabilitation of the Tuberculous at the British Legion Village, Preston Hall, near Maidstone, from Thursday, October 12, to Saturday, October 14, 1950. The course is primarily intended for:

- (a) Members of Hospital Management Committees.
- (b) Hospital Administrators.
- (c) Delegates from British Legion Branches.
- (d) Social Welfare Officers.
- (e) National Assistance Board Officers.
- (f) Local Authority Lay Officials.
- (g) Medical Practitioners and Nurses.

Lectures will be given on the following subjects:

Tuberculosis as an industrial problem.
Rehabilitation in the ward—i.e., diversional therapy and vocational guidance.
Financial problems of rehabilitation.
Development and functions of disabled persons workshops.
Suitable and unsuitable employment for the tuberculous, etc.

Opportunities will be given for tours of local industries.

Preston Hall, British Legion Village, is two miles the London side of Maidstone on the London to Folkestone road, and there is an hourly train service of one hour's duration to and from London. The fee for the course is £2 2s.

Those wishing to attend are asked to make early application and state whether accommodation is desired. Every endeavour will be made to make suitable arrangements in the vicinity of Maidstone.

NAPT SCHOLARSHIP FOR SCOTTISH QUEEN'S NURSE

A Scholarship of £100 to £150 will be awarded by the National Association for the Prevention of Tuberculosis to a registered female nurse working at the time of her application in Scotland, whose name is on the Queen's Roll of the Queen's Institute of District Nursing. Preference will be given to a nurse working in the Highlands. The Scholarship will enable her to spend a period of from three to six months in post-graduate study, in hospitals or clinics in (a) Scotland, (b) England, or (c) Scandinavia.

Candidates should state age, qualifications and previous experience; reasons for wishing to do post-graduate work in tuberculosis; and should affirm their intention to continue in tuberculosis work after attaining the Scholarship.

Application should be made to Miss A. J. Weir, Scottish Secretary, N.A.P.T., 65, Castle Street, Edinburgh 2, by November 1, 1950.

"All interested in Tuberculosis, who read this book, will appreciate the masterly way in which the gradual unfolding of the story of phthisiology has been told in the lives of these twelve great men."—BULLETIN OF HYGIENE.

Tuberculosis in History

S. LYLE CUMMINS

C.B., C.M.G., LL.D., M.D.

*Late Colonel, Army Medical Services; formerly Professor of Tuberculosis,
Welsb National School of Medicine.*

THIS BOOK sets forth the lives and achievements of some of those older workers on tuberculosis who built up the volume of knowledge which we possess today. Part 1 tells the stories of the earlier British observers whose contributions were so valuable from a clinical point of view as well as from the philosophical standpoint, while Part 2 gives some account of the wonderful scientists in the study of tuberculosis who arose on the Continent during the latter part of the 18th Century.

Of the "Moderns" the author feels, in general, that it is too soon to write, but in Part 3 he has set down the story of Edward Trudeau's successful fight against the disease, and of the achievement of Robert Koch in discovering and isolating the germ and making it possible for us to contend with a tangible enemy.

As SIR ARTHUR SALUSBURY MACNALT says in his Foreword: "The medical historian, the specialist in tuberculosis, and the general reader can equally enjoy this book and after perusal will feel grateful to Professor Cummins for writing it."

The book is beautifully illustrated with photogravure reproductions of contemporary portraits.

Pp. xiv + 205

Price 21s.

Postage 8d.

Baillière, Tindall and Cox

7-8 HENRIETTA STREET, COVENT GARDEN

LONDON, W.C.2